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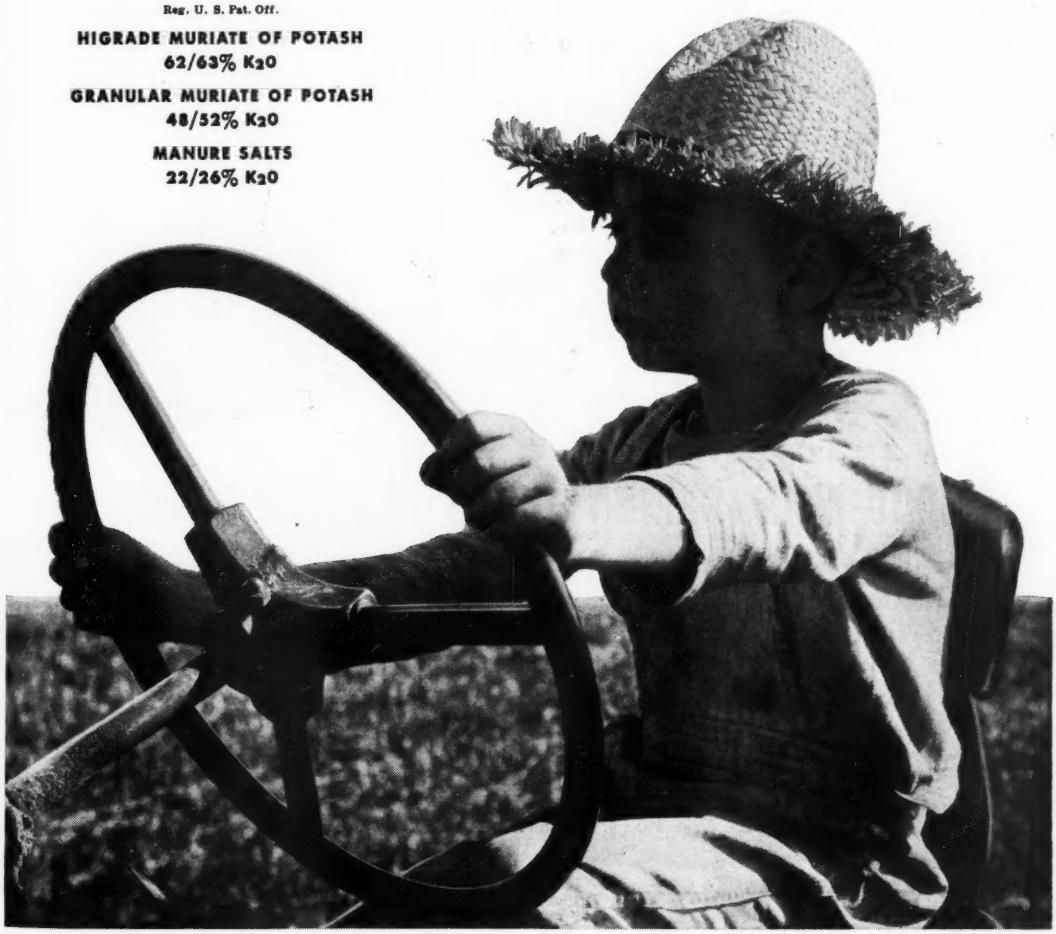

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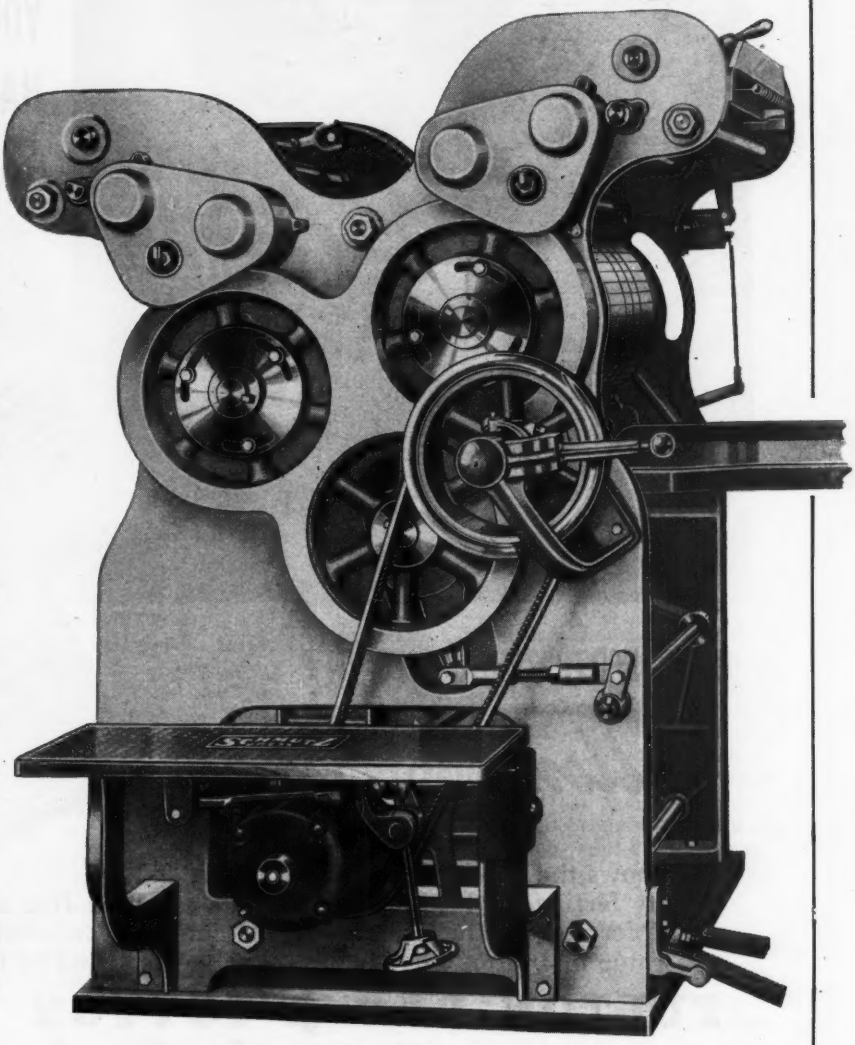

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The American FERTILIZER

Vol. 107 NOVEMBER 1, 1947 No. 9

Boron Research in Agriculture*

By JAMES A. NAFTEL
Pacific Coast Borax Company

As a result of the numerous investigations on boron in agriculture, particularly during the last decade, both industry and agriculture have come to appreciate the importance of this essential element. In fact, results from the soil application of small amounts of boron in deficient areas have caused some agricultural scientists to consider boron research at the top of the list of urgently needed fundamental research. As a specific example of how boron is influencing the agriculture of a region, the legume, livestock and year-around grazing program of the Southeast is cited. This was reported by Hendricks (*3*)† and has continued at a rapid increase.

In common with other experiences with new discoveries, boron fertilization problems become more complex as time goes on. In order to properly use and control boron in agriculture, more fundamental research is needed. Many of the earlier studies reported the *effects* only and now there is need for determining the *cause* which involves the fundamental nature of the plant, soil and fertilizer reactions involving boron. To add to the complexity of the boron situation, is the apparent minute quantity required by plants throughout their life cycle. A shortage of boron during any phase of the plant's life affects the growing part. How can this small continuous supply of boron be best maintained for growing crops? Although some State authorities are attempting to answer this problem by recommending a minimum amount of borax in each ton of fertilizer sold in the State (*8*), some phases of this problem remain for future research.

Present Status of Boron Research

The crop needs for boron fertilization may be conveniently discussed from the standpoints of (a) well-established needs, (b) new crop responses, and (c) future developments with other crops.

Crops with Established Boron Fertilization Needs.—It is generally well known that many crops respond to boron fertilization at least in large areas. Truck crops with well established response include beets, cabbage, cauliflower, celery, lettuce, radishes, rutabagas, tomatoes, and turnips; field crops include alfalfa, crimson clover (*6*), and red clover, and especially in the seed production of these crops; fruit crops include apples and citrus. In the above crops boron fertilization is generally recommended and practiced.

Newly Reported Crop Response.—Of the recently reported responses of crops, bur clover, cotton, sweet corn, sweet potatoes and tobacco may be added to the growing list of plants where definite field response has been obtained. It should be stated that most of these crops are responding to smaller amounts of boron and also tolerating smaller amounts than the older established crops

* Presented before the Fertilizer Chemistry Division of the 112th meeting of the American Chemical Society in New York, September 15, 1947.

† Numbers in parentheses refer to references cited at end of article.

discussed above. Notable in this regard is tobacco where the extremely small amount of two and one-half pounds per acre is recommended and gives striking response (*5*). Perhaps outstanding in the new crops reported to respond to boron are sweet potatoes (*7*) and sweet corn in South Carolina by Nusbaum. Quality and yield of these two crops were increased by an application of only 5 pounds of borax per acre.

Future Boron Development with Other Crops.—Crops with indications of probable boron fertilization requirements are corn, small grains and pastures. Corn has shown in isolated field tests some response to boron and it is not unlikely that in the Southeast where the trend in corn production is toward much higher fertilization, closer spacing and use of hybrids, minor elements including boron will be required. Barley and wheat have been reported to give some beneficial response to boron. Improved grass-legume pastures are receiving more and more fertilization and White Dutch clover and bur clover are known to respond to boron (*4*).

IMPROVED LEGUME-GRASS PASTURE IN ALABAMA

Borax in fertilizers is contributing to the establishment of the "legume, livestock and year-around grazing program" of the Southeast.—Photo courtesy ofAlabama Ext. Serv.

Problems for Boron Research

Problems in the fertilizer use of boron logically fall into those concerning the agricultural scientist and those involving the fertilizer industry.

Problems Faced by Agricultural Scientists.—The need for and use of boron in the widely differing crops and soils remain a problem and will require continued alertness by agronomists in order to guide the practical use of boron fertilization. Methods for the determination of boron-deficient soils have been continually improved by use of chemical methods and plant indicators but still need further calibration. Perhaps a combination of chemical methods and plant indications will prove most practical as now used by some states, notably by New Jersey (*8*).

Fundamental reactions between soil components and the physiological effects of boron in the plant have been under investigation throughout the world but there is still a lack of complete understanding of the phenom-

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Hardpan, Plowsole, and Compacted Soils*

By ARTHUR M. SMITH
Stamford, Connecticut

THE war-time demand for farm crops, and the continuing necessity for supplying the peoples of impoverished countries, has brought about the use of a succession of record-breaking quantities of commercial fertilizers. Even though the distribution and amount of rainfall have been favorable in most of the important crop areas during most of these years, the heavier rates of fertilizer application in the old consuming areas and the appreciable use of fertilizer in many new areas in the West have brought into focus the importance of water in relation to crop growth and the effective use of commercial plant food. Whatever limits the supply of water during the growing season may limit the return from fertilizers.

The plant breeders, plant physiologists, farm crops agronomists and horticulturists, the soil and fertilizer chemists, and more recently the agricultural engineers and farm machinery manufacturers, through study, research and demonstrations have brought to the farmers of most sections an intelligent approach that has helped solve the problems of field crop production. Average yields per acre and per man of economically important farm crops have been steadily increased, and production of most field crops has been placed on a more sound economic basis. War-time prices have made the gross financial return per acre for most crops more profitable than ever before in the history of our country.

However, it should be realized that in many soils the application of chemical fertilizers speeds up those biological and chemical reactions that bring about physical changes in soil structure; changes that may result unfavorably with reference to tilth, aeration, drainage, and moisture supply, and which in the adjacent undisturbed soils may be proceeding at a much slower rate. Some of these reactions, especially in humid and semi-humid regions, may in effect change deep soils to shallow soils and greatly reduce the water available to crops during a part of the growing season.

It is time for chemists, physiologists, and crop scientists engaged in plant nutrition work, and in fact for all who have an economic stake in field practices on farms, to give more and increasing attention to the physical structure of the soil, and even to its morphology and genesis, in order that moisture deficiency may, insofar as rainfall or supply of irrigation water permits, be removed as a limiting factor in the returns farmers receive from their investments in fertilizers. The research and demonstration work done by the chemists, physiologists and plant breeders has paid big dividends. Soil physics, soil morphology, and soil genesis as scientific tools have been relatively neglected; possibly because not so spectacular, hence not so popular, and in part because of the longer time factor.

The war-time demand for crops speeded up many things. Farmers did the necessary, used what was obtainable, and learned to do by doing. In some places, heavy applications of fertilizers proved profitable where, experimentally, previous small applications had seemed uneconomical. Prior to 1940, except for irrigated areas, the fertilizer industry regarded as doubtful territory any section of less than 25 inches average annual rainfall. Farmers are now using fertilizers profitably on many such areas; and the plant physiologist can easily explain that a sufficiency of plant food elements greatly reduces the transpiration ratio, and hence the amount of water required to produce economic crop yields.

Fertilizers in Semi-Arid Areas

However, the long time problem is with us, and is more clearly in focus than before. Any and all who are interested in selling plant food over a period of years in areas having 12 to 25 inches annual rainfall would do well to study fertility levels and transpiration ratios; to determine how many feet or inches of friable soil over hardpan, claypan,

*A paper presented at the meeting of the American Chemical Society, Division of Fertilizer Chemistry, New York, September 17, 1947.

plowsole or whatever the impervious layer may be, their present and prospective customers have in the important crop areas they wish to serve. And in the humid areas east of the Mississippi River this matter of hardpan, plowsole, or whatever it is locally, while not nearly so prevalent, is important in any sizable area of crop land with less than a ten per cent slope; for hardpans, claypans, and even plowsoles form and are found almost exclusively in relatively flat or gently sloping areas. There is plenty of evidence to indicate that the situation is accentuated by the residual effect of heavy fertilizer applications. Even irrigation, if there were enough water available for all the acreage in such areas—which there is not—would not permanently alleviate the situation; in fact, it might bring the inevitable result more quickly. The physical effect of hard or impervious layers of soil relatively near the surface is the same in either humid or dry areas, in that it reduces the effective moisture supply available to crops. The chemical changes that cause such hard or impervious layers may be quite variable, as may also the residual effect of any given type of fertilizer, and the materials which may be applied to counteract a natural or an induced tendency toward formation of these layers.

In this country the research and investigational work on hardpans, claypans, and siltpans has been conducted largely by the Division of Soil Survey of the United States Department of Agriculture Bureau of Plant Industry, Soils and Agricultural Engineering. Such technical information as is contained in this paper is taken largely from reports and papers published by or cooperatively with the Division of Soil Survey. The author is indebted to Dr. Charles E. Kellogg, Chief of the Division of Soil Survey, for very helpful information including a list of references. The author realizes the danger of minor inaccuracies of statement in the attempt to summarize, and possibly to over-simplify, an intricate, complex and somewhat neglected subject for the purpose of suggesting further research and a practical effort to overcome what in some sections has long been a detrimental situation and is becoming so in others. Generalizations may be made, but they can neither be accurate nor all inclusive.

Definition of Terms

According to Nikiforoff (*5*)†: "Hardpan is a horizon of soil more or less irreversibly cemented by some compounds, among which silica and sesquioxides probably predominate . . . One may visualize the development of the hardpan as a periodic deposition of films of cementing compounds such as free silica, alumina, and iron oxides, which saturate a thin layer of coarser particles and paste them to the surface of a previous accumulation of the same formation . . . The fresh films quickly change their dull gray color to deep red on drying . . . This color is probably caused by free iron oxides of the hematite type (Fe_2O_3), set free by decomposition of alumino silicates." Nikiforoff and Alexander (*6*) state: ". . . that the topmost part of hardpan usually is the hardest and that its upper boundary is abrupt, whereas the lower boundary is less distinct and cannot be determined precisely in most places."

The Soil Survey Report for Polk County, Florida, by Earl D. Fowler and others (*2*) contains the following with reference to the hardpan that is characteristic of the Leon Fine Sand soil type: "The surface soil, as a rule, is divided by a sharply defined line from the underlying brown, very dark brown or almost black hard compact fine sand, commonly termed "hardpan," which averages 3 to 6 inches in thickness . . . The dark brown organic layer, or so-called hardpan stratum, is extremely acid and contains a concentration of organic acids and iron salts in many places. This layer has apparently developed at approximately the average ground water level. It retards both the downward movement of percolating water and the upward movement of water by capillarity."

According to Nikiforoff and Alexander (*6*): "Claypan is a dense and heavy soil horizon, or a layer of the parent material, which is characterized by a conspicuously large content of clay. It differs from hardpan especially in the lack of permanent induration. As a general rule the hardpan soils are more common in arid and sub-arid regions, whereas the claypan soils develop predominantly in rather humid regions. Many exceptions to this rule, however, can be mentioned. For example, ortstein is the iron hardpan that develops in the B horizon of the groundwater podzols in humid regions, whereas the well developed claypan is not an unusual characteristic of various desert soils."

Siltpan is a dense heavy layer, usually underlying the surface soil, characterized by a large content of silt. Usually it is neither so dense nor so impervious to water as claypan.

In a recent letter to the author, Dr. Charles E. Kellogg (*3*) wrote in part as follows re-

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†Numbers in parentheses refer to Literature Cited at end of paper.

Fertilizer Control Officials Hold Successful Convention

The first annual convention of the Association of American Fertilizer Control Officials was held at the Shoreham Hotel, Washington, D. C., on October 21st. Members were present from more than 40 State Control Departments and the registry of attendance included many leading agronomists, fertilizer manufacturing executives and representatives of the trade press.

President D. S. Coltrane opened the afternoon session with a review of the Association's work during the past year. The model Fertilizer Control Bill which was proposed at the organization meeting in 1946 has undergone revision, following conference with U. S. D. A. officials, agronomists, fertilizer manufacturers and others. A Fourth Draft of this bill is now in course of preparation and will be released in the near future.

Mr. Coltrane then outlined the qualifications needed by the ideal fertilizer control officials: "The fertilizer control official should be a good administrator. He should be able to preside over conferences in a fair but objective manner. His motives must, at all times, be constructive. He should be a practicable sort of fellow—one who looks at things from an objective viewpoint rather than from a technical or narrow angle. He should have a thorough knowledge of the fertilizer business from the point of production and supply of materials to their use in the field. He should be familiar with the manufacture and sale of fertilizers. If there is a fertilizer control official who has not been through a fertilizer plant, he should go through one or more plants at the earliest possible date; become familiar with the process of manufacturing, distribution, and sale of fertilizers; then he will have a more sympathetic and practicable viewpoint toward the manufacturer and his problems.

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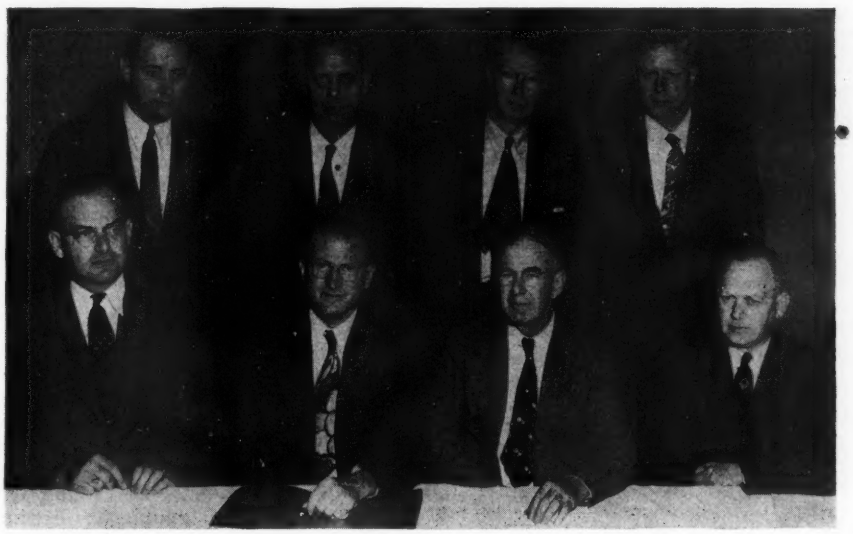

Officers of the Association of American Fertilizer Control Officials

Left to right, front row: B. D. Cloaninger, head of the Department of Fertilizer Inspection and Analysis, Clemson College, Clemson, South Carolina, vice-president; Allen B. Lemmon, chief of the Bureau of Chemistry of the Department of Agriculture, Sacramento, California, president; D. S. Coltrane, Assistant Commissioner of Agriculture for North Carolina, member of the Executive Committee and retiring president; Henry R. Walls, chief chemist of the Feed and Fertilizer Inspection Service, College Park, Maryland, re-elected secretary-treasurer. Top row, all members of the Executive Committee: Dr. F. W. Quackenbush, State chemist, Department of Agricultural Chemistry, Indiana Agricultural Experiment Station, Lafayette; Dr. J. F. Fudge, State chemist, College Station, Texas; L. S. Walker, chemist in charge Regulatory Service, Vermont Agricultural Experiment Station, Burlington and W. B. Griem, State chemist, State Department of Agriculture, Madison, Wisconsin.—*Photo by American Plant Food Council.*

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N. F. A. Fall Meeting

With the opening of a fertilizer season in which supply, and not demand, will be the all-important problem, the fertilizer industry is making plans to attend the fall meeting of The National Fertilizer Association, to be held at the Atlanta Biltmore Hotel, Atlanta, Georgia, on November 10th, 11th and 12th.

Tuesday, November 11th

The opening day, Monday, November 10th, will be devoted to meetings of the Board of Directors and of the various Association Committees. The first general session will be held on Tuesday morning, November 11th, with Weller Noble, Chairman of the Board of Directors, presiding. After a message from Mr. Noble, the meeting will be addressed by Donald Comer, president of Avondale Mills, Birmingham, Alabama, who is one of the leading industrialists of the South.

The closing feature of this session will be a discussion panel presented by the N. F. A. Plant Food Research Committee, under the chairmanship of Dr. H. B. Siems. The panel will include the chairmen of the subcommittees who will cover the work of their particular sections as brought out by questions from the chairman. The audience will be asked to participate by asking other questions which may be suggested by the discussion.

The annual dinner will be held at the Biltmore at 7 P. M. on Tuesday evening. The program is in charge of J. Rucker McCarty and his hospitality committee.

Wednesday, November 12th

The program for Wednesday, November 12th, will include talks by Maurice H. Lockwood, President of the Association, whose subject will be "Firm Foundations"; Omer S. Kelley, Agricultural Research Administration, U. S. D. A., Fort Collins, Colorado, who will speak on unique fertilizer work in irrigated areas; L. R. Neel, editor of *Southern Agriculturist*, Nashville, Tennessee; W. B. Andrews, Mississippi State College and Agricultural Experiment Station, State College, Mississippi, who will discuss the use of anhydrous ammonia for direct application in the field.

No meetings have been scheduled for the afternoons of November 11th and 12th. Arrangements have been made for golfing privileges at the Atlanta Athletic Club for the three days of the convention, and at the

Capital City Country Club and the Druid Hills Golf Club on the 11th and 12th, these two latter clubs being closed on Mondays. Those desiring courtesy cards should apply in advance to J. W. Rutland, Potash Division, International Minerals & Chemical Corp., Volunteer Building, Atlanta 3, Georgia.

The hospitality committee which is in charge of arrangements consists of J. Rucker McCarty, Chairman; W. W. Barton, D. W. Brooks, M. S. Hodgson, R. L. King, George W. McCarty, J. W. Rutland, George W. Suggs, and A. L. Wiley.

"What's in a Bag of Fertilizer?"

The National Fertilizer Association has issued a small (3½ by 5½ inches) 8-page pamphlet entitled *W at's in a Bag of Fertilizer?*, which should be of great service to the entire fertilizer industry. In simple, direct language, intended primarily for the farmers of the country, this pocket-sized booklet explains the basic reasons for the composition of mixed fertilizers.

It explains clearly the meaning of the figures in a fertilizer grade and shows why there are limits to the amount of plant food that a fertilizer can contain. Other subjects which are covered are secondary or so-called "inert" ingredients, and fillers.

The booklet will be a valuable sales aid to every fertilizer manufacturer. Quantity prices may be obtained by writing to the offices of the National Fertilizer Association, 616 Investment Building, Washington 5, D. C.

Barton Elected Chairman of Lion Oil Company Board

At a meeting of the Board of Directors, held October 22nd, Col. T. H. Barton was elected Chairman of the Board of Lion Oil Company, and T. M. Martin was elected president. This action was taken on the recommendation of Col. Barton who has been president of the Company since 1929. He felt that the expanding activities of the Company warranted an active board chairman and at the same time gives an opportunity for the advancement of the younger executives who have contributed greatly to its growth.

Mr. Martin has served as vice-president since 1929 and as executive vice-president since 1939. He has been active in the petroleum business since 1923 at which time he was engaged in an oil brokerage business in Chicago. Later he served as general manager of Diamond Petroleum Company at Louisville, Kentucky, which became a part of the Mid-Continent Petroleum Corporation. In 1929, at the age.of 34, he was elected director and vice-president of Lion Oil Company.

Armour to Offer Packaged Fertilizer Line

Armour Fertilizer Works has announced their entrance into the packaged fertilizer field. This new product, which has been named "Velvetgreen" has been developed for garden vegetables, flowers, lawns, shrubs and trees, and has been tested under varying climatic conditions in many sections of the country.

Velvetgreen will be packed in waterproof paper bags of 1, 10, 25 and 100 pounds, and will be distributed through the company's 25 plants and sales offices. An intensive advertising campaign will be used to introduce this product to the general public early next year.

James K. Welch Company Re-opens Offices

The James K. Welch Company, dealing in heavy chemicals, fertilizer materials, animal feeds, greases, fish meal, scrap and oil, have re-opened their offices at 90 West Broadway, New York City. Mr. Welch conducted this business at the above address until he was called into active duty in the Army in 1942. Prior to forming his own business, he was a partner in the firm of H. J. Baker & Bro., New York.

Texas Fertilizer Sales Increase

According to figures released by J. F. Fudge, State chemist, sales of fertilizers in Texas for the first six months of this year totaled 252,098 tons which is 18 per cent above the sales for the same period of 1946. Mixed goods accounted for 186,815 tons and individual materials for 65,283 tons. Of the mixed fertilizer sold, 88 per cent consisted of two grades: 4-12-4, 104,852 tons; and 5-10-5, 60,691 tons. A new high-analysis mixture, 16-20-0, sold in the amount of 4,856 tons. The leading materials sold for direct application were 20 per cent superphosphate 28,667 tons, and ammonium nitrate 16,030 tons.

September Tag Sales

Fertilizer tax tag sales in 16 States during September amounted to 520,000 equivalent short tons, according to reports of State control officials to The National Fertilizer Association. Although the tonnage was lower than for last September, it was higher than for any other September and was 375 per cent higher than the September average for 1935–1939.

Sales in the 11 Southern States, which were equivalent to 362,000 tons, were 10 per cent below last year, but 25 per cent above September, 1945. Compared with a year ago, September sales were lower for six States; decreases ranged from 3 per cent for Louisiana to 47 per cent for Alabama, with the drop in Florida tonnage from 106,000 tons in September of last year to 59,000 this September being the most significant. Increases in the other five States ranged from 2 per cent for Arkansas to 201 per cent for Tennessee. Texas, for the first time, reported a larger monthly tonnage than any of the 16 States; generally, the largest monthly tonnage is reported by one of the States along the Atlantic coast.

The five Midwestern States reported sales during September equivalent to 158,000 short tons; this was a drop of about 400 tons from last year and an increase of 72,000 tons from September, 1945. Three of the States, Indiana, Kentucky, and Kansas, reported increases over the preceding September, with

(Continued on page 20)

FERTILIZER TAX TAG SALES
COMPILED BY THE NATIONAL FERTILIZER ASSOCIATION

State	September 1947 Tons	September 1946 Tons	September 1945 Tons	January–September % of 1946	January–September 1947 Tons	January–September 1946 Tons	January–September 1945 Tons
Virginia	33,554	38,362	34,616	99	541,554	547,278	499,250
North Carolina	48,328	43,919	36,878	98	1,250,719	1,282,051	1,207,850
South Carolina	38,940	31,514	14,725	95	687,489	724,035	691,980
Georgia	12,646	13,447	22,075	99	941,819	946,189	929,848
Florida	58,704	106,155	60,280	79	575,297	724,232	590,928
Alabama	11,050	20,900	16,300	83	611,500	732,550	649,100
Tennessee	15,897	5,275	5,042	108	299,071	277,694	247,227
Arkansas	4,351	4,250	1,800	102	139,868	137,050	110,200
Louisiana	60,125	61,800	75,050	96	191,943	200,418	207,486
Texas	66,990	62,127	21,630	110	317,045	287,832	174,915
Oklahoma	11,140	13,228	1,000	140	68,432	48,976	19,362
Total South	361,725	400,977	289,396	95	5,624,737	5,908,305	5,328,146
Indiana	55,659	43,877	34,423	111	548,005	491,742	382,040
Illinois	33,500	40,670	27,825	113	300,875	266,553	206,764
Kentucky	26,128	17,325	10,420	116	323,720	277,991	247,241
Missouri	27,425	44,548	10,280	90	214,161	237,759	145,246
Kansas	15,195	11,903	3,000	194	101,018	51,988	34,305
Total Midwest	157,907	158,323	85,948	112	1,487,779	1,326,033	1,015,596
Grand Total	519,632	559,300	375,344	98	7,112,516	7,234,338	6,343,742

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FERTILIZER MATERIALS MARKET

NEW YORK

Box Car Shortage Seriously Hampers Shipments of Materials. Very Little Material Available for Current Purchase. Organics Market Unsettled. Sulphate of Ammonia Production Continues High.

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, October 29, 1947.

The organic market had a rather mixed tone the last few days, due to the unsettlement of prices in the feed industry. Most feed buyers are remaining out of the market temporarily until they can get a better picture of future business. Animal tankage was offered at $10.00 ($12.16 per unit N) with not much interest displayed by buyers. Blood is not too plentiful and could be purchased at $9.50 ($11.55 per unit N) for quick shipment. Vegetable meals were a little easy in price due to the greater amount of offerings coming on the market. Soybean meal fluctuated between $72.00 per ton and $80.00 per ton in bulk, f.o.b. Decatur, and cottonseed meal was quoted at $86.00 pert on. Fish meal, however, remained firm in price because of the small amount of material available for quick shipment. Due to the warm weather the fishing companies were able to continue their operations a little later than usual. It is expected as soon as the cold weather sets in the demand for all feed materials will pick up.

Potash

One large company notified the trade it is having great difficulty getting necessary boxcars to make shipments and may be forced to curtail its production, due to lack of storage space at the plant unless the situation is corrected shortly. Buyers are eagerly seeking supplies on contracts and pressing suppliers for delivery dates.

Superphosphate

Increased inquiry was noted for triple superphosphate, but as manufacturers have already sold on contract their estimated production, it is most difficult to find any material in the open market for quick shipment. Twenty per cent superphosphate was moving along on contracts at a good rate.

Sulphate of Ammonia

Steel production continued good and producers are shipping on old contracts but fertilizer manufacturers could use a larger quantity than already purchased if supplies were available. Export demand continued good with very little material to be had.

Bone Meal

Demand continued excellent from various sections and very little was available for prompt shipment. The production is expected to fall off during the winter months.

Castor Pomace

No material was available for sale as production is uncertain. The demand was very heavy for this material from various sections.

Nitrogenous Tankage

Producers have not raised their prices, in spite of some reports to the contrary, and have already sold their estimated production. Demand is excellent.

Nitrate of Soda

Importers are hopeful of being able to fill their quotas that have been set for the current year and are trying to provide an equitable distribution of the material. Very little domestic material was available.

Garbage Tankage

There were a number of large inquiries in the market for this material but no offerings. Some buyers are considering using substitute materials such as cocoa shells, humus, etc.

Charleston

Boxcar Shortage Becoming Serious. Material Accumulating at Producing Plants. Shipments of Mixed Goods Beginning.

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, October 28, 1947.

The fall movement of raw materials and mixed fertilizers is beginning to get under way heavily and the boxcar shortage is being felt acutely throughout the fertilizer industry. Prices on raw materials are firm in general, particularly on the prime ingredients: superphosphate, nitrogen and potash. These three materials continue short of demand.

Organics.—Decline in buying interest on the part of the feed trade has resulted recently in lower prices on organics such as blood and tankage. Domestic nitrogenous continues in a light offering status and prices are unchanged, the last being sold at $6.50 per unit of ammonia ($7.90 per unit N), f.o.b. Midwestern production point, for fall shipment. Very little, if any, foreign nitrogenous is offered.

Castor Pomace.—The price, according to last reports, is around $40.00 per ton in bags, f.o.b. works. Present production is being shipped against existing contracts and little or no additional material is offered for sale.

Potash.—The shortage of boxcars has reached a serious stage and stocks of potash are piling up at the mines for lack of transportation facilities. Demand continues extremely strong and potash now is considered the most acutely short of the three main fertilizer ingredients. No price change has been indicated recently. Some French potash has sold at 95 cents per unit, in bulk, ex-vessel Baltimore, Norfolk and Savannah, seller's option, for November through June arrival.

Nitrate of Soda.—The market continues firm and demand increasing strongly. Importations are on schedule and domestic production continues curtailed for lack of raw materials. Prices remain unchanged.

Sulphate of Ammonia.—Demand is extremely strong on this material and stocks are below last year's tonnages for this same time. Supply is expected to be below demand for the entire season.

Dried Ground Blood.—Demand has fallen off as the feed market reduced its demand. South American material has been offered for November-December shipment at around $9.55 per unit of ammonia ($11.61 per unit N), c.i.f. Atlantic port in bags. Domestic blood can probably be bought at $9.00 to $9.50 ($10.94 to $11.55 per unit N) in bulk, f.o.b. Chicago, with very little interest from the fertilizer trade.

Hoof and Horn Meal.—South American material has been offered recently at $8.25 to $8.75 ($10.02 to $10.63 per unit N) c.i.f. Atlantic port for fall shipment from South America.

Tankage.—Price has dropped in the last week or two and this material can probably be obtained at around $10.00 to $10.50 ($12.15 to $12.76 per unit N), f.o.b. Chicago, but little fertilizer trade interest is shown.

Superphosphate.—Few manufacturers are able to accumulate any stocks as demand continues strong and prices firm. The only impediment to movement of superphosphate is the shortage of boxcars which gets more acute as the fall movement of all materials increases.

Phosphate Rock.—Boxcar shortage in addition to heavy demand continues to keep this market tight.

PHILADELPHIA

Car Shortage Affects Material Shipments. Fall Nitrogen Exports Heavy. European Materials Production Improving

Exclusive Correspondence to "The American Fertilizer"

PHILADELPHIA, October 27, 1947.

Production of basic fertilizer chemicals is still not able to keep up with the demand, and the shortage of boxcars continues to be serious. Goods that are moving now are almost entirely on contracts and productions are sold well ahead. It is generally recognized that there will again be a world shortage of nitrogen, although it is reported that France hopes to be self-sufficient in 1948, due to her rapidly expanding production.

Sulphate of Ammonia.—Although production has increased, it is not able to keep up with demand, and the supply position is reported tight. Market is nominal at $35.00 to $40.00 per ton, in bulk at producing works. Shipments are mainly against contracts.

Nitrate of Soda.—Shipments from Chile are arriving in due order, with the greater portion of tonnage being stored against later demands. No free offerings are reported.

Nitrate of Ammonia.—Demand continues strong, and in the light of orders said to have been issued by International Emergency Food Council for export shipments during October, November and December, it is predicted that domestic consumers will be

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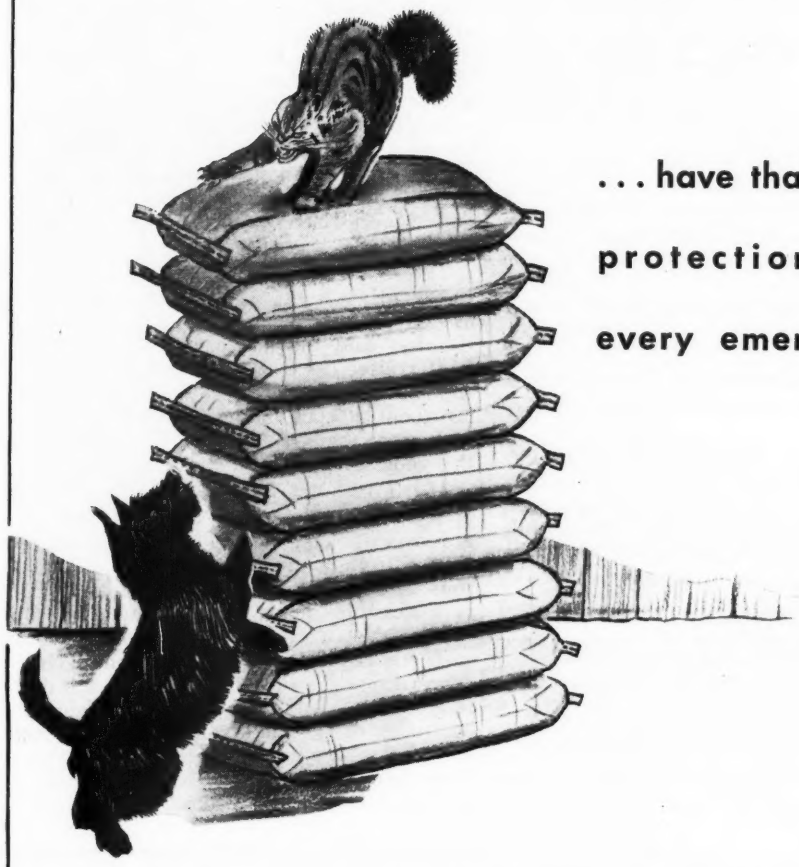

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getting very slim deliveries until probably January, 1948.

Castor Pomace.—No free offerings are reported, and the market continues nominally at $40.00 per ton. Any movements are on contracts.

Tankage, Blood, Bone.—Market for blood and tankage is rather quiet with no selling pressure, and with buyers showing little, or no interest. An odd car infrequently finds itself in fertilizer hands, but the real outlet is to feeders. While bone meal is not in excessive supply, it is able to keep up with the demand. Steamed 70 per cent B.P.L. was priced at $58.00 per ton.

Fish Scrap.—Demand has been fairly active from feeding trade, with price ranging from $145.00 to $150.00 per ton for meal.

Phosphate Rock.—Conditions continue tight with demand for more than can be currently supplied. While the empty car situation has improved slightly, it is still abnormal. Production abroad is improving.

Superphosphate.—Buying situation is tight with most productions sold ahead. It is reported that all forms of sulphuric acid are short.

Potash.—Boxcar shortage is causing piling up of stocks and some of the producers say they will have to shut down if the situation does not improve immediately. Meanwhile European production is increasing.

CHICAGO

Organic Materials Still Out of Fertilizer Price Range. Feed Material Market Easier

Exclusive Correspondence to "The American Fertilizer"

CHICAGO, October 25, 1947.

The organic materials market remains a routine affair, with offerings few and far between, although inquiry is about as it has been during the past few months.

A somewhat easier feeling in the market for wet and dry rendered tankage is noticeable and such conditions naturally affect the market for blood. Prices for these materials are still far in excess of their fertilizer values.

N. F. A. Entertains A. O. A. C.

At the 61st Annual Meeting of the Association of Official Agricultural Chemists, held at the Shoreham Hotel, Washington, D. C., on October 20th, 21st and 22nd, the officials of the Association were tendered a welcoming dinner by The National Fertilizer Association, as has been the custom for many years. The speakers on this occasion were George P. Callister, chairman of the fertilizer committee of the International Emergency Food Council, and Maurice H. Lockwood, President of the N. F. A.

The subject covered by both speakers was the fertilizer needs of European agriculture as involved in the Marshall Plan. Mr. Callister said that the shortage of nitrogen for fertilizer use is now greater than at any time during the past eight years. With needs for about 800,000 more tons than is in sight at present, he saw little hope of making up this shortage in the near future.

Mr. Lockwood spoke in more detail on present commitments. For 1947–48, the government has allotted for export 52,600 tons N from commercial sources and 230,000 tons N from Army Ordnance plants. "This is a sizeable quantity of nitrogen in any man's book," said Mr. Lockwood. "It is earnestly hoped that our government agencies concerned with additional nitrogen will carefully survey conditions in the participating countries to ascertain the extent to which these countries might be able to increase their own production instead of calling on us for additional allocations."

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International To Build Kentucky Plant

International Minerals & Chemical Corporation expects to begin construction shortly of a plant in Somerset, Kentucky, designed to produce from 12 to 15 thousand tons of mixed fertilizers annually.

According to Louis Ware, president, the Somerset plant will be the first to be erected by the corporation in Kentucky. At present, it operates 31 other fertilizer plants in 15 States throughout the country.

When finished, the plant will measure approximately 160 by 200 feet and will be located on an eight acre plot outside the city limits along the Southern Railway. Construction is expected to be completed next spring according to present plans.

The plant will utilize raw materials from International's own mines in manufacturing the finished product. Potash will be obtained from International's mine in Carlsbad, New Mexico, while phosphate rock will come from its mine in Bartow, Florida.

August Superphosphate Production

Production of superphosphate during August totaled 797,000 equivalent short tons (basis 18% A. P. A.), according to reports submitted to The National Fertilizer Association and a summary of reports submitted to the Bureau of the Census. Production in August was 15 per cent above the 702,000 tons reported for a year ago, and, in fact, was higher than for any month in 1946, but lower than for any month this year. Shipments were 13 per cent greater than last August, and end of month stocks were 20 per cent greater.

August production of normal superphosphate, totaling 715,000 tons, was 14 per cent above last year, while the production of 31,000 tons of concentrated superphosphate (45% basis) increased 7 per cent over a year ago.

Production	Normal 18% A. P. A. Tons	Concentrated 45% A. P. A. Tons	Base Goods 18% A. P. A. Tons
August, 1947.....	715,003	30,749	5,397
July, 1947.....	712,600	33,810	4,710
August, 1946.....	625,845	28,730	3,852
Shipments and Used in Producing Plants			
August, 1947.....	762,231	29,605	1,785
July, 1947.....	677,388	33,222	2,171
August, 1946.....	652,707	31,552	1,440
Stocks on Hand			
Aug. 31, 1947....	705,855	60,439	9,966
July 31, 1947.....	749,473	59,021	6,354
Aug. 31, 1946....	597,000	46,507	7,249

SEPTEMBER TAG SALES

(Continued from page 14)

Kentucky having the largest percentage increase. The other two States, Illinois and Missouri, reported decreases of 18 and 38 per cent, respectively.

January–September sales in the 16 States, totaling 7,113,000 equivalent tons, were 2 per cent below the 7,234,000 tons reported for the same period last year, but 12 per cent above January–September, 1945.

In the 11 Southern States, cumulative sales amounted to 5,625,000 tons, a decrease of 5 per cent from last year. Four States registered increases while the other seven, including those with the greatest tag sales,

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reported decreases; in the States where sales are greatest, however. the decreases were small. January–September sales in the five Midwestern States, amounting to 1,488,000 tons, were 12 per cent above a year ago. Sales in Missouri fell 10 per cent from last year, but sales in the other four States increased.

FERTILIZER CONTROL OFFICIALS

(Continued from page 11)

"The control official should know the agronomic value of fertilizers. It would be best that he know the soils of his State and their response to different fertilizers. Perhaps one of the major qualifications for a good fertilizer control official is tolerance toward minor or technical violations of the law. For example, it would, in my opinion, be unwise to penalize a manufacturer for .60 per cent deficiency in available phosphoric acid if the nitrogen and potash were in excess of the guarantee in a sufficient amount as to give the fertilizer a value well in excess of the guaranteed value. On the other hand, he should not allow one ingredient to offset another in an amount sufficient to materially change the grade or crop production of the fertilizer. The control official should use his law as the yardstick for the assessment of penalties and then exercise discretion and judgment; otherwise, he might just as well turn the job over to an intelligent clerk.

"Someone has said that a fertilizer control official should not be a politician. He should certainly not be a peanut politician, but I am not so certain but that he should be one of the best of politicians. To say the least, he should have tact, be firm but fair, keep his character above reproach, and use a lot of good common horse sense. Above everything, he should remember that his primary job is to protect his farmers, the consumers of the fertilizer and the great majority of manufacturers who make their fertilizer as labeled and guaranteed. You are the farmers' sole protector, whereas the manufacturer hires chemists to protect his interest."

After discussing the features that should be included in a fertilizer control law, Mr. Coltrane listed some of the essentials that should concern the control officials. These are: 1. Grade standardization; 2. Uniform guarantees and labeling requirements; 3. Uniform registration blanks; 4. Increased plant food content; 5. The use of fillers and related matters; 6. Improved technique in the sampling of fertilizers.

Dr. John R. Taylor, Jr., agronomist of the American Plant Food Council, addressed the convention and congratulated the control officials on the work they are doing in the impartial enforcement of the State fertilizer laws. He emphasized the need of keeping these laws modern and up-to-date and touched on other pertinent subjects such as minor element deficiencies in the soils, sampling, accurate fertilizer consumption figures, cooperation of industry agronomists and chemist with State officials, and the expansion of fertilizer production facilities.

Maurice H. Lockwood, president of the National Fertilizer Association, presented a graphic picture of the advances that have been made by the industry during the past few years both in volume of fertilizers produced and in average plant food content. From estimates of materials supply, he predicted that fertilizer production in the 1947–48 season would total 17,000,000 tons. In the use of fertilizer on principal crops, corn leads with 21.3 per cent of the total 1946 consumption, followed by small grains, 13.9 per cent; vegetables, 10.5 per cent; cotton, 9.8 per cent; potatoes, 6.6 per cent; tobacco, 6.6 per cent; hay, 6.0 per cent; fruit and nuts, 6.3 per cent; pasture, 5,3 per cent; sweet potatoes, 1.0 per cent; other crops, 12.7 per cent.

Other speakers at the afternoon session were W. A. Minor, Assistant to the U. S. Secretary of Agriculture, who spoke on the outlook for 1947–48; Allen B. Lemmon, Sacramento, California, "Liquid Fertilizers"; R. A. Maddox, Jackson, Mississippi, "Anhydrous Ammonia and Nitrogen Solutions";

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The members of the Association and their guests were entertained at a dinner given by the American Plant Food Council. Clifton A. Woodrum, president of the Council, presided and emphasized the importance of Americans being able to live their own lives, achieve their own successes and make their own mistakes. In reply, President Coltrane affirmed his belief in our system of free enterprise and in the greater efficiency and economy of private manufacturing.

The evening session was devoted to a discussion of a number of problems, including labeling for secondary and minor plant foods, new phosphate materials, fertilizer inspectors' equipment, control problems in the fertilizer factory, liming materials, the use of fertilizer tonnage data.

coming year were elected as follows: president, Allen B. Lemmon, Sacramento, California; vice-president, B. D. Cloaninger, Clemson, South Carolina; secretary-treasurer, Henry R. Walls, College Park, Maryland; Executive Committee, F. W. Quackenbush, Lafayette, Indiana; J. F. Fudge, College Station, Texas, W. B. Griem, Madison, Wisconsin, D. S. Coltrane, Raleigh, North Carolina.

BORON RESEARCH IN AGRICULTURE

(Continued from page 8)

enon. The best-known relationship is that between lime and boron and now it is known how to avoid unfavorable balance between these two essential elements. Although it is known that lime reduces the solubility of boron in soils (*6*) and that certain ratios of Ca to B are favorable to plants (*2*), the exact mechanism is not clear. Additional field data are needed on the influence of potassium on boron fertilization practices. There have been widespread observations on the influence of moisture (drouth) on boron in field crops. Boron seems to avoid some drouth injury, particularly on alfalfa and apples, but this relationship is not clearly understood. More attention is now being given to the relation of organic matter content of soils to boron availability. The well-known buffering effect and adsorption capacity of soil organic matter appear to play a more important role in boron relationships than has been attributed to it.

Educational work is needed among all fertilizer users of the importance and value of the relatively small concentration of boron required by many plants. This is a serious problem that is retarding the proper use of boron in some of our fertilizer practices. There are many farmers, and fertilizer people as well, who consider 5, 10, or even 25 pounds of borax per acre as insignificant and useless in such small amounts. Perhaps a greater appreciation would be obtained if the small rates of borax would be expressed in molecules per acre!

The stepped-up intensity of production of crops by higher fertilization, closer spacing of plants and use of hybrids or other improved varieties of crops is increasing the need for providing boron, as well as other minor elements, in the fertilizer practices. A good example of this is in the high fertilization corn production of the South where minor element deficiencies are being observed for the first time. These changed conditions may call for the re-investigation of soil fertilizer requirements by such crops.

Problems Encountered by the Fertilizer Industry.—The fertilizer industry, by its competitive nature, is interested in producing the most efficient fertilizer formula possible for the various crops. In this, the industry is guided in the requirements or grades recommended by the State agricultural authorities. The industry is therefore dependent on the agronomist for its developments and changes. Among the recent changes is the inclusion of boron in mixed fertilizers for certain crops and in certain areas. As with all changes, certain problems arise; some of these are discussed below.

The grade or formula to contain boron is one of the foremost questions among fertilizer mixers. Some States, notably New Jersey (*8*) and South Carolina (*1*), have suggested that all fertilizers carry a minimum content of boron to avoid widespread deficiency of boron. Other states recommend boron in certain fertilizers only, particularly for alfalfa

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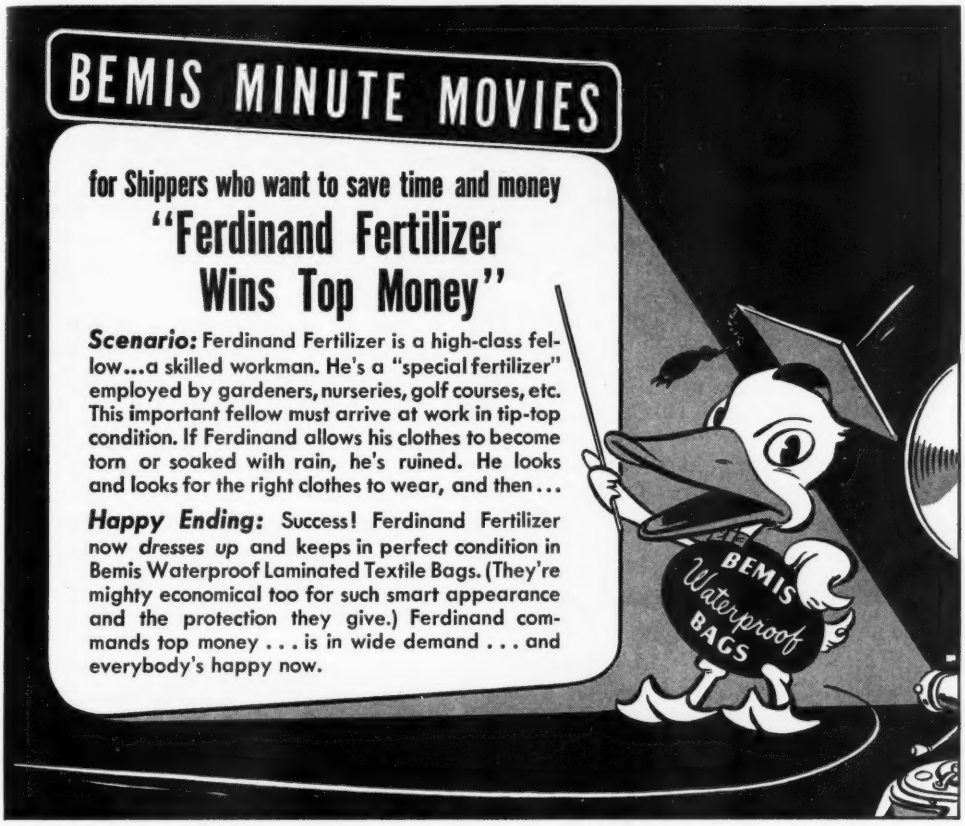
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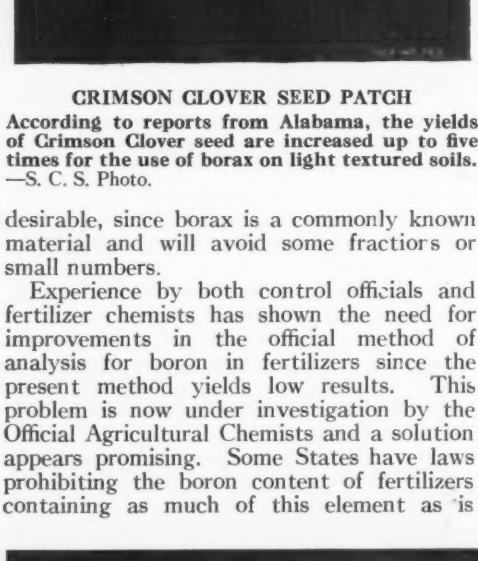
or other legumes. Due to the variation of boron tolerances of some crops and to variation of soils, a problem is raised as to the concentration of boron to mix into the fertilizer. It will require further research to determine if 5 to 10 pounds of borax per ton of fertilizer will suffice for general crops. The problem of mixing a homogeneous grade of fertilizer arises when minimum amounts of 5 to 10 pounds of borax per ton are added to fertilizers. This is influenced by the fineness of both the borax and the fertilizer.

Control officials and agronomists are now considering how the boron content of fertilizers shall be stated on the analysis tag. The present trend is to report this as pounds of borax per 100 pounds of fertilizer or the percentage borax contained. This would appear



CRIMSON CLOVER SEED PATCH

According to reports from Alabama, the yields of Crimson Clover seed are increased up to five times for the use of borax on light textured soils. —S. C. S. Photo.

desirable, since borax is a commonly known material and will avoid some fractiors or small numbers.

Experience by both control officials and fertilizer chemists has shown the need for improvements in the official method of analysis for boron in fertilizers since the present method yields low results. This problem is now under investigation by the Official Agricultural Chemists and a solution appears promising. Some States have laws prohibiting the boron content of fertilizers containing as much of this element as is recommended at present by the agronomist; obviously these laws have served their purposes and should be modified.

Summary

In conclusion, there is continued high interest in boron fertilization by both agriculture and industry. This is due to the striking results obtained with boron fertilization on many crops and soils and to the attention being shown to higher productivity through higher rates and more efficient fertilizers.

It may be expected that conditions and factors favor an increasing need for and use of boron in fertilizers. Some of these factors are greater use of lime and higher purity fertilizer materials, increased rate and vigor of growth, closer spacing of crops, new varieties and hybrids, and to the loss of boron from the soil.

To keep pace with the increasing need and use of boron, continued research is not only desirable but is an essential phase of further development in the production of more efficient grades and use of commercial fertilizers.

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HARDPAN, PLOWSOLE & COMPACTED SOILS

(Continued from page 10)

garding plowsoles: "These seem to develop as the result of the packing caused by plowing with a moldboard plow. They are most commonly developed in soils with a high content of exchangeable hydrogen, and especially in those with a high content of exchangeable sodium. They are more likely to form when the land is plowed a little on the wet side. With repeated plowing at the same depth, they become quite thick. In those I have examined, the soil in the plowsole is made up of a series of thin, brittle horizontal plates. I have seen these develop badly in the normal Chestnut soils of Western North Dakota, even where there is no high percentage of exchangeable sodium, after being plowed a few times with the moldboard plow at the same depth. I know of other soils that have been plowed for years and years at the same depth but with no tendency at all toward the formation of a plowsole. The reasons for these differences are not clear. An intelligent farmer will recognize the condition if he has it, and will avoid the difficulty by using a chisel to break it up where it has formed, by incorporation of organic matter, and the avoidance of the use of the moldboard plow."

This compacting effect of the moldboard plow, when used on heavy soils at above optimum moisture content, has long been recognized, as attested by the following quotation from the 1909 edition of Soils, by Lyon and Fippin (*4*) ". . . It is important to consider what Professor Roberts called the plow sole. That is, the soil at the bottom of the furrow which bears the weight of the plow and trampling of the team, and which, under uniform depth of plowing, does not become loosened. In clay soil, especially, it gradually becomes more compact, in time developing something of a 'hard-pan' character, which is detrimental to the circulation of air and moisture and interferes with the penetration of plant roots. Consequently, occasional deep plowing or even subsoiling is recommended to break up this unfavorable soil structure, commonly called the 'plow sole.' There is less tendency for the disc than the moldboard plow to form the 'sole'."

Compacted Soils

Probably from the beginning herdsmen and farmers noticed the puddling effect of livestock grazing on heavy soil pasture lands. Heavy soils, when very wet, can be badly puddled or compacted by the weight of even very light animals or farm equipment. The gasoline engine has resulted in the ever heavier equipment used on our increasingly modernized farms; so that at present harmful compaction of silt and clay loam soils is possible even at slightly over optimum moisture contents for crop growth. The chemical reactions that largely determine the physical condition of the soil colloids are, therefore, of greater interest and importance than ever before.

All of these problem conditions: hardpan, claypan, siltpan, plowsole and compacted soils have a common factor, namely, the colloidal portion of the soil. Brought about by widely differing external forces or internal conditions, the resulting density, duration and hardness are directly correlated with the chemical composition of the soil colloids as influenced by currently active or previously existing biological and chemical reactions. All of these conditions have been recognized, described and remedial procedures recommended for many years. Blowing holes through hardpan with dynamite to plant orchard trees, breaking up hardpan layers or plowsole with the subsoil plow, and plowing-in organic matter in the form of manures and green manures have all been helpful in offsetting these conditions. But these remedial procedures can be only of temporary and inadequate effect so long as the conditions which cause the colloids to cement more or less permanently continue unchanged.

Humid Areas

In humid areas the cementing effect has always been preceded by losses of calcium and magnesium through leaching and/or cropping. The accumulation or formation and later precipitation of soluble silica, iron, aluminum and organic matter in the subsoil at or slightly above ground-water levels, or in the zone in which the downward percolation and the upward capillary water movements balance, usually takes place in a highly acid medium. The colloids of surface acid soils in humid areas are more easily compacted than in non-acid or well limed soils. The most effective economic treatment for field soils would seem to be surface liming for puddled or compacted soils, and plowsole application of relatively large quantities of lime to combat plowsole, siltpan, claypan and even hardpan. The growing of deep-rooted legumes should be helpful, but is it necessary to comment that root penetration by these crops is many times greater when ample calcium for their nutrition has been applied?

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Less Humid Areas

In sections having less than 25 inches annual rainfall the hardpan and claypan layers are usually calcareous. Large soil areas are underlain by a calcareous subsoil which may vary in hardness and impermeability at different times of year and according to the duration of and temperatures during the dry season. The effect is often an extremely shallow soil with respect to moisture absorption, storage capacity, and drainage. In these soils calcium carbonate is an important cementing material. In drier sections and locally where surface evaporation of seepage water results in appreciable accumulations of sodium salts, the cementing forms a true hardpan. Even in areas where the *p*H of the surface soil may be distinctly on the acid side, the hardpan layer usually ranges from *p*H 7.0 to above 8.0. Since the use of sulphur has been shown to increase the permeability of alkaline soils to water, reduce the percentage of clods, and increase the depth of penetration of legume roots on such soils (*1*), it seems at present to be the logical material for improving the physical condition of calcareous and alkaline soils; by making surface applications on alkaline surface soils, and plowsole applications for calcareous subsoils and hardpans.

Any physical condition of the soil which interferes with the drainage, or with the storage capacity of the soil for capillary water, also interferes to like extent with soil aeration. As school children we were taught to breath deeply from time to time to fill the lungs with oxygen and expel waste products. A shallow soil breathes shallowly, for although the oxygen dissolved in rain water does add appreciable quantities of oxygen to the soil, it is the diurnal and seasonal breathing resulting from alternate heating and cooling of the soil that expels gaseous products of decomposition and draws large amounts of fresh air and oxygen into the soil. Naturally air thus incorporated cannot penetrate through any impervious layer.

The residual salts from fertilizer applications react on the soil minerals. The heavier and the more frequent the fertilizer applications, the more rapid the effect in changing solids to colloidal gels, suspensions, sols and true solutions; forms which may be carried downward by the movement of gravitational (hydrostatic) water or upward by the movement of capillary water. The great bulk of the phosphate compounds applied in fertilizers are acidic; the lowest cost nitrogen compounds are acidic; the potash compounds are mostly neutral, but in acid soils the residual potash may be caught and reverted or cemented in the colloidal complex under drouthy conditions. While there is much evidence that acidic materials or combinations are the indicated best forms for application to alkaline soils, except when it is necessary to obtain available calcium or magnesium by applying as the neutral salt of a strong acid, it is equally indicated that farmers must lime acid soils for the effect on either the surface soil or the subsoil layers or both. Until farmers on the acid soils of the humid regions do adopt and consistently follow an adequate liming program, fertilizer manufacturers are justified and should still be encouraged to market non-acid-forming mixtures for most crops.

More Study Needed

The physical aspects of soil science and soil management should have more attention in research, investigation and demonstration. The biological and chemical reactions resulting from heavier manuring and fertilizing practices should be studied with respect to their effect on soil tilth, structure, aeration, drainage, and capillary water capacity. The bio-physical and physico-chemical relationships in soils have become increasingly important with heavier fertilizer applications in the humid areas and with the use of fertilizers in new areas of limited or deficient rainfall. Whether working in national, State, or commercial organizations, all scientists interested in plant nutrition have an economic interest in improving those physical soil conditions described by the terms hardpan, plowsole, and compacted soils.

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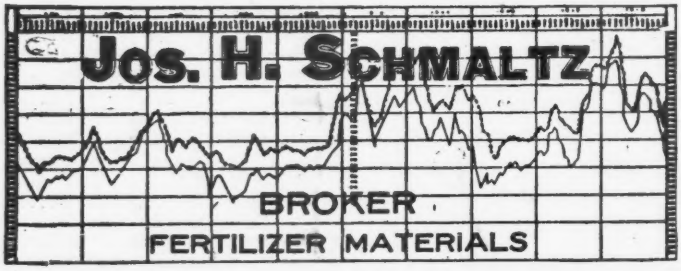

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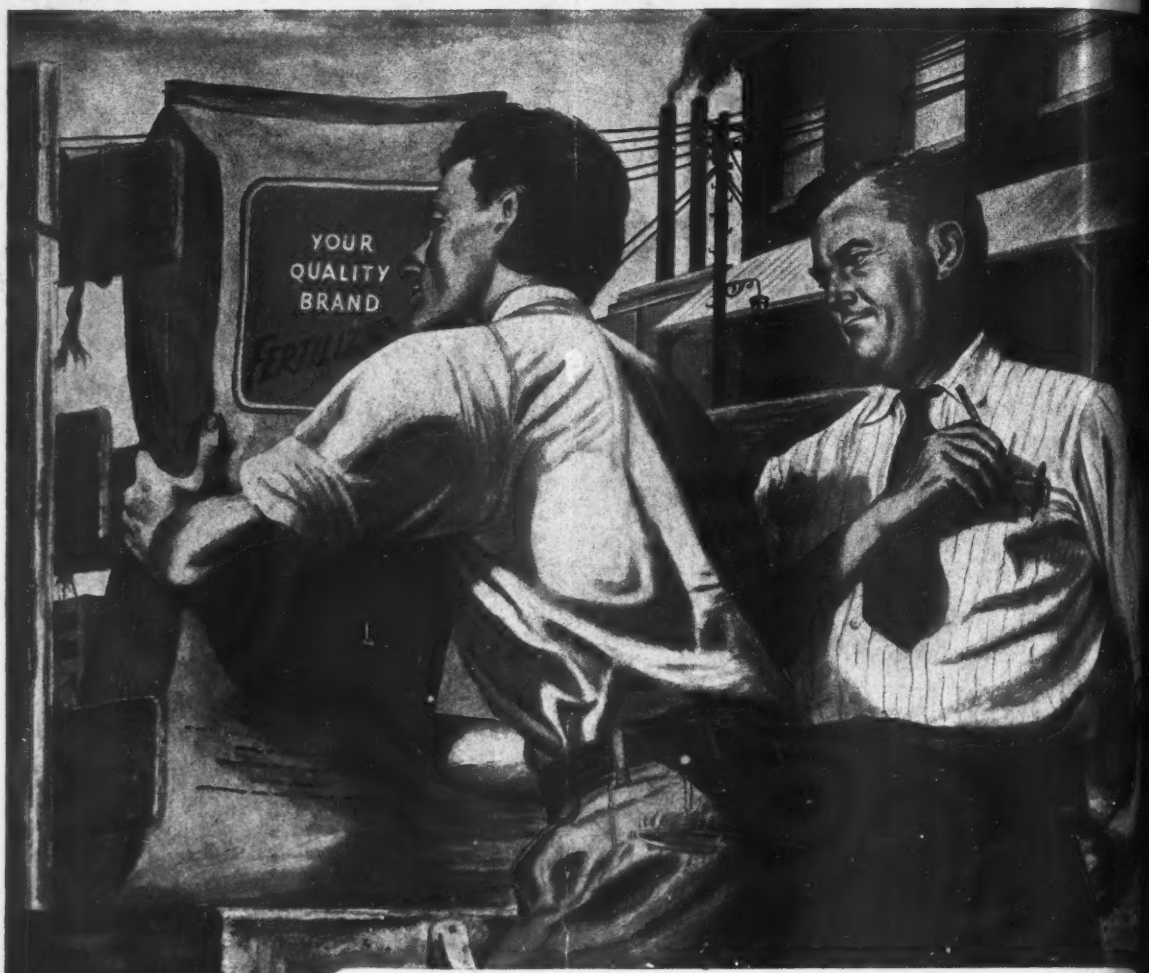

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